

SPEECH RECOGNITION SYSTEM FOR ELECTRONIC SWITCHES
IN A NON-WIRELINE COMMUNICATIONS NETWORK

CROSS REFERENCE TO RELATED APPLICATION

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5 ~~This application is a continuation of copending
application U.S. Serial No. 07/867,873 filed April 13, 1992,
now U.S. Patent No. 5,297,183.~~

TECHNICAL FIELD

10 This invention is related to telecommunications systems,
and more particularly to an electronic digital signal
processor-controlled telecommunications system for the
recognition of spoken commands and for the directing of
telephone calls based on spoken commands.

BACKGROUND OF THE INVENTION

15 It is well-known that many of the safety hazards of
cellular telephone use could be alleviated by utilizing
automatic speech recognition. While telephone-based speech
recognition systems are known, cellular voice dialing over a
mobile telephone exchange ("MTX") presents significant
challenges for two basic reasons. First, the recognition
20 technology must accommodate a tremendous range of both
remotely-mounted and hand-held microphone types. Second, the
signal may be band-limited and degraded in transmission to the
MTX where the recognition system will be located.
Voice-controlled dialers of the prior art, such as taught in
25 U.S. Patent No. 4,853,953 to Fujisaki, have not been
successfully implemented in the cellular environment.

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There is therefore a need for voice recognition systems for use in the cellular, satellite and and personal communications network environments that overcome these and other problems of the prior art and that facilitate the use of voice-dialing and other safety and convenience features.

BRIEF SUMMARY OF THE INVENTION

It is therefore an object of the present invention to describe an implementation of a speech recognition system in a cellular or personal communications network environment.

It is a further object of the invention to describe a speech recognition system for use at a mobile telephone exchange (MTX) of a cellular or personal communications network. The placement of the speech recognition system at the MTX significantly reduces cost and increases reliability by enabling the switch vendor to install and maintain the system in conjunction with the cellular switch.

It is another object of the invention to describe a cellular voice dialing system for use in or in conjunction with an MTX of a cellular network.

It is still another object of the invention to use voice recognition techniques to secure access to a cellular or personal communications network.

Another object of the invention is to provide for combined use of speaker-dependent and speaker-independent voice recognition and speaker verification techniques in an MTX of a cellular or personal communications telephone network.

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These and other objects of the invention are provided in an advanced system for the recognizing of spoken commands over the cellular telephone or any personal communications (i.e., any non-wireline) network. In the cellular application, for example, a Speech Recognition System interconnects either internally with or as an external peripheral to a cellular telecommunications MTX switch. The Speech Recognition System includes an administrative subsystem, a call processing subsystem, a speaker-dependent recognition subsystem, a speaker-independent recognition subsystem, and a data storage subsystem. The Speech Recognition System also allows for increased efficiency in the cellular telephone network by integrating with the switch or switches as a shared resource. The administrative subsystem of the Speech Recognition System is used to keep statistical logs of pertinent call information. Pre-recorded instructional messages are stored in the memory of the call processing subsystem for instructing a user on his or her progress in using the system. The speaker-independent recognition subsystem allows the user to interact with the system employing non-user specific functions. User specific functions are controlled with the speaker-dependent recognition subsystem. User specific attributes collected by the recognition subsystems are stored in the data storage subsystem.

The foregoing has outlined some of the more pertinent objects of the present invention. These objects should be

construed to be merely illustrative of some of the more prominent features and applications of the invention. Many other beneficial results can be attained by applying the disclosed invention in a different manner or modifying the invention as will be described. Accordingly, other objects and a fuller understanding of the invention may be had by referring to the following Detailed Description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference should be made to the following Detailed Description taken in connection with the accompanying drawings in which:

FIGURE 1 is a block diagram of a cellular telephone network incorporating an external switch-based Speech Recognition System according to the present invention;

FIGURE 2 is a block diagram of a cellular telephone network incorporating an internal switch-based Speech Recognition System;

FIGURE 3 is an upper level block diagram of the Speech Recognition System and data storage subsystem of FIGURE 1;

FIGURE 4 is a detailed component diagram of the speech recognizer board of the Speech Recognition System of FIGURES 2 and 3;

FIGURE 5 is a flowchart showing a Control routine used in the Speech Recognition System;

FIGURE 6 is a flowchart of the Dial routine of the invention used by the subscriber to voice dial a telephone number that has been previously-stored by the subscriber;

5 FIGURE 7 is a flowchart of the Call routine used by the subscriber to voice dial a speaker-independent telephone number;

FIGURE 8 is a flowchart of the Directory Dialing routine used by the subscriber to recall a previously-stored number using a speaker-dependent directory name;

10 FIGURE 9 is a flowchart of a Store routine used to store subscriber-specific destination number information;

FIGURE 10 is a flowchart of a Memory routine used to store speed-dial numbers associated with specific memory locations; and

15 FIGURE 11 is a flowchart of a Directory Storage routine used to store speaker-dependent directory names and associated telephone numbers for use by the subscriber to speed-dial destination numbers based on the associated directory names.

20 Similar reference characters refer to similar parts or steps throughout the several drawings.

DETAILED DESCRIPTION

FIGURE 1 is a block diagram of a cellular telephone network incorporating an external switch-based Speech Recognition System according to the present invention.

25 Although the following description is specifically related to use of the Speech Recognition System at or in conjunction with

an MTX of a cellular network, it should be appreciated that the System also interconnects either internally with or as an external peripheral to a personal communications network. Indeed, the principles of the invention are applicable to any cellular-like network application, i.e., where a non-wireline communications network is employed for mobile, satellite, portable or personal communications. The Speech Recognition System can also be used as a shared resource through integration with a plurality of such non-wireline communications networks.

Referring now to FIGURE 1, an exemplary telephone network is a cellular network 10 having a mobile telephone exchange (MTX) switch 12 connected to a transceiver and an antenna 14. The transceiver is located in each cell of the cellular network and communicates with the MTX to effect transmission and reception of signals to and from the mobile telephone located in vehicle 15. The transceiver is typically connected to the MTX via a leased or dedicated network line 11. The MTX 12 is typically connected to the land-based destinations via telephone network 16.

A cellular mobile telecommunications system connects mobile telecommunications customers, each having a mobile unit, to land-based customers served by a telephone network. Incoming and outgoing calls are routed through a mobile telecommunications switching office connected to a group of cell sites that communicate with mobile units. The mobile

telecommunications switching office includes a mobile telephone switching exchange (MTX) for routing the calls between the mobile units and the telephone network. In a typically mobile cellular communications system, there are usually many cells per MTX and several MTX's per system. As used herein, "mobile telecommunications system" refers to cellular, satellite and personal communications network environments.

Each cellular telephone is uniquely identified by two numbers: a serial number ("ESN") encoded in the phone by its manufacturer, and a mobile identification number ("MIN"), which is the cellular telephone number programmed in by the cellular service provider. The service provider operates the MTX 12 and keeps a database of all MIN's (and their associated ESN's). Each time a call is placed by the cellular telephone, the service provider verifies whether the MIN and the associated ESN are authorized. If the MIN and ESN of a cellular phone are not recognized (and the area code or NPA of the MIN indicates that the phone number is outside of the provider's service area), the provider normally allows the call to proceed at least one time. If billing authorization cannot later be verified, however, the MIN and serial number are then placed on an exception list. Subsequent attempts to use the MIN will then be rejected.

According to one embodiment of the invention as shown in FIGURE 1, a Speech Recognition System 20 is connected as an

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external peripheral to the MTX through a set of preferably digital trunk lines. Set 22 is used for incoming signals and set 24 is used for outgoing signals. Other types of signaling, such as CEPT E1 or analog, may also be used besides T1. The Speech Recognition System 20 is connected to a dedicated data storage subsystem 26 through a data network 28. The data storage subsystem is used to store recognition data derived from the subscribers to the voice dialing service as will be described. The Speech Recognition System 20 may be integrated with one or more switches (whether or not cellular) for use as a shared resource via incoming and outgoing trunk sets 30 and 32.

Referring now to FIGURE 2, a block diagram shows the cellular telephone network 10' with the Speech Recognition System 20 interconnected internally to the MTX. This is the preferred embodiment of the invention. The hierarchical architecture of the cellular switch includes the central processing unit 33, memory 34, data storage disk 35, cellular interface 36, central office trunk interface 37 and a backplane or switching matrix 38.

The Speech Recognition System 20 includes a number of functional subsystems: an administrative subsystem 21, a call processing subsystem 23, a speaker-dependent recognition subsystem 25, a speaker-independent recognition subsystem 27, and the data storage subsystem 29 (which corresponds to the storage system 26 of FIGURE 1). The administrative subsystem

The CPU 40 and associated control programs function as the system administrative subsystem 21 of FIGURE 2. The recognizer board 41 acts as the recognition call processing subsystem 23 and the recognition subsystems 25 and 27.

5 Command and control functions are communicated to the recognizer board 41 from the system administrative processor 40 to the recognition call processing subsystem through a system bus. Responses received by the administrative processor from the recognition subsystem indicate primary and
10 secondary recognition responses, error codes and command acknowledgements.

Referring now to FIGURE 4, a more detailed schematic diagram is shown of the recognizer board 41 of FIGURE 3 and modules 25 and 27 of FIGURE 2. The recognizer includes a
15 control digital signal processor ("DSP") 50 having an associated memory 51 for supporting control programs and data. The control DSP 50 in this embodiment of the invention controls a plurality of speech recognition digital signal processors 52a...52d via a control bus 53. The control DSP 50
20 also connects to an interface processor 54 via a host port interface 55. Interface processor 54 has its own processor memory 56. A buffer 57 interconnects the interface processor to a system bus interface circuit 58 that interconnects the recognizer board to the system bus.

25 The PCM highway of FIGURE 3 or backplane of FIGURE 2 is connected to a PCM highway interface circuit 59 that supplies

speech sample information to the control DSP 50 and memory 51 via address and data buses 60 and 61. Each of the speech recognition DSP's 52a...52d has an associated memory 62a...62d and storage buffer 63a...63d. Buffered address and data buses 5 64 and 65 interconnect to the address and data buses 60 and 61 through the buffers 66.

The interface processor 64 converts batch system commands or command blocks received through the system bus interface 58 into singular commands for the control DSP 50. Similarly, 10 singular responses from the control DSP 50 are buffered by the interface processor 54 and are sent to the administrative processor (of FIGURES 2 and 3) in code blocks to increase overall system efficiency.

All telephone channel signaling and PCM highway sample 15 transfer is handled by the control DSP 50 through the PCM highway interface 59. The control DSP 50 is also used to send samples and commands to the four speech recognition DSP's 52a...52d. Additionally, the DSP's 52 can function to stop outgoing messages based on detection of certain incoming 20 speech energy.

The system data flow is such that recognition commands and responses are sent to and from the administrative processor and the speech recognition DSP's 52 through the control DSP 50, the interface processor 54, and the system bus 25 interface 58. Speech samples are received by the speech

recognition DSP's 52 through the PCM highway interface 59 and the control DSP 50.

5 The present invention facilitates the implementation of voice-dialing in a cellular telephone or other personal communications network environment. When a user "subscribes" to the service (e.g., with the MTX service provider), it is desirable that certain speech data be collected from the subscriber for security purposes. Thus, upon subscription, the user normally will be asked to provide his or her native language (e.g., English, Spanish, French, etc.), a personal identification number, and personal information related specifically to the subscriber such as a social security number or date of birth. This latter information may be used in an automated query process as will be described to prevent fraudulent use of the cellular or personal telephone network. Once the user information is activated in the system, the user may place or receive telephone calls. Initially, the user will be required to enter speed-dial numbers and their associated directory names.

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20 Referring now to FIGURE 5, a functional flowchart is provided describing the basic control functions of the Speech Recognition System according to the present invention. The routine begins at step 102 when the user dials digits from the cellular telephone. At step 104, a test is performed to determine if a Speech Recognition System access code has been dialed. If not, the cellular switch processes the call based

In particular, a test is made at step 116 to determine if the Dial command is recognized. If so, control is transferred to the routine of FIGURE 6. If the response to the test at step 116 is negative, a test is made at step 118 to determine if a "Call" command has been spoken and recognized. If the system recognizes a "Call" Command, control is passed to the Call Routine of FIGURE 7. If the response to the test at step 118 is negative, a test is made at step 120 to determine if a "Directory" command has been spoken and recognized. If the system recognizes a "Directory" Command, control is passed to the Directory Dialing Routine of FIGURE 8.

If the result of the test at step 120 is negative, a test is made at step 122 to determine if the user has spoken a "Quit" command. If so, the routine terminates. If the result of the test at step 122 is negative, the Speech Recognition System responds with a error message in step 124. A test is then performed at step 126 to determine if a predetermined maximum error count has been reached. If not, control is transferred back to step 114. If the predetermined maximum error count has been reached, the call and the MIN is transferred to an operator at step 128 and the routine ends.

Referring now to FIGURE 6, the Dial Routine is described in detail. At step 130, the Speech Recognition System prompts the user with a message, such as "Phone Number Please," and applies the speaker-independent recognizer to collect the digits. A test is performed at step 132 to determine whether

speaker-independent recognition subsystem is engaged at step 150.

At step 152, the subsystem attempts to verify the called number. If the verification command is not recognized, the
5 Speech Recognition System responds at step 154 with a message such as "Error, Please repeat," and control returns back to step 152. If the outcome of the test at step 152 is positive, the telephone number is repeated to the user at step 156 and the speaker-independent recognition subsystem is engaged.

10 A test is then made at step 158 to determine whether the user (by spoken command) desires to "Store" the number. If yes, the control is transferred to the Store routine of FIGURE 9. If the outcome of the test at step 158 is negative, a test
15 162 is made to determine whether the user has spoken (and the recognizer has recognized) a "Send" command. If not, the Speech Recognition System again plays an error message at step 164 and control is returned to step 158. A positive response to the "Send" test made at step 162 transfers the MIN and the string dialed to the switch for outdialing. Such transfer
20 occurs at step 166. At step 168, the switch dials the telephone number and connects the user to the dialed number.

The Call routine is shown in detail in FIGURE 7. The routine begins at step 170 during which the Speech Recognition
25 System responds to the user's "Call" command with a message "Calling." At step 172, the speaker independent recognition subsystem is engaged to obtain the user's response. A test

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is then made at step 174 to determine if the user speaks a "Memory" command, indicating that the number to be called is to be stored and made available for speed-dialing once a preferably two digit memory location number is subsequently received. If the outcome of the test at step 174 is positive, the Speech Recognition System queries the user "Which memory" and engages the recognition subsystem at step 176. At step 178, a test is made to determine if a two digit memory location has been identified by the user. If a two digit memory location has not been identified, a timeout test is performed at step 180. If timeout occurs, the Speech Recognition System prompts the user to "Please enter next digit" at step 182 and control is returned to step 178. A negative outcome of the timeout test also returns control back to step 178.

A positive outcome of the test at step 178 indicates that the two digit memory code has been received. The routine then recalls the previously-stored telephone number associated with the memory code at step 184. The Speech Recognition System then notifies issues a "Calling" message to the user at step 186.

A user may also retrieve the stored telephone number by speaking one of the speaker-independent key words. Thus, if the outcome of the test at step 174 is negative, the routine continues at step 187 with the user speaking a valid key word associated with one or more previously-stored telephone

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numbers. Without limitation, such key words include HOME, OFFICE, TIME, SECRETARY, FRIEND, WORK and INFORMATION. A test is then made at step 188 to determine if the word spoken is a valid key word. If not, the system responds with an error message at step 190 and asks the user to speak the word again at step 187. A positive outcome to the test at step 188 transfers control to step 186.

At step 192, the speaker-independent subsystem is again engaged to obtain a user command. A test is made at step 194 to determine whether the user desires to "Verify" the number retrieved. If a "Verify" command is spoken and recognized, the stored number associated with the key word is repeated to the user and the recognizer is engaged at step 196. A test is then made at step 198 to determine whether the user desires to "Clear" the number retrieved and start again. If so, the Speech Recognition System responds with a "Ready" message at step 200 and control returns to step 187.

If, however, the outcome of the test at either step 194 or step 198 is negative, a test is made at step 202 to determine if a "Send" command has been spoken and recognized. If not, the system responds with an error message at step 204 and returns to step 192. If the user speaks the "Send" message, the Speech Recognition System responds at step 206 with a "Dialing" message. At step 208, the System transfers the MIN and the telephone number to be dialed to the switch

for outdialing. The switch dials the telephone number and connects the user to the dialed number at step 210.

Referring now to FIGURE 8, a flowchart is shown of the Directory Dialing routine. This routine is called when the user desires to recall and dial some previously-stored telephone numbers using a previously-stored speaker-dependent name. In response to the "Directory" command from the user, the routine plays a message at step 212 to request the name in the directory. Step 212 also engages the speaker-dependent recognition subsystem. A test is then made at step 214 to determine if the name has been collected from the speaker. If no response is obtained, a timeout test is performed at step 216. Failure of the speaker to respond before the end of the timeout causes the issuance of an error message at step 218 and the routine returns to step 214. If the timeout occurs without the speaker's response, control is transferred back to step 212.

A positive outcome of the test at step 214 means that the directory name spoken by the user has been recognized. The routine then continues at step 220 and recalls from the data storage subsystem a number associated with such name. At step 222, the stored number is played to the user and the Speech Recognition System issues a "Correct" prompt. A test is then made at step 224 to determine if the number is correct. If not, control is returned back to step 212. If the outcome of the test at step 224 is positive, then the Speech Recognition

System responds with a "Dialing" message at step 226. At step 228, the System transfers the MIN and the telephone number to be dialed to the switch for outdialing. The switch dials the telephone number and connects the user to the dialed number at
5 step 230.

Referring now to the Store routine FIGURE 9, a flowchart is shown of a routine used by the subscriber to store telephone numbers for the two digit memory codes, keywords, and directory names to be later dialed. The routine begins in
10 response to receipt of a speaker-independent "Store" command spoken by the user to update the speed-dial list whenever necessary. At step 232, the routine responds to the command with a "Storing" message and engages the speaker-independent recognition subsystem. A test is then made at step 234 to
15 determine whether the user desires to store two digit memory codes. If so, control is transferred to the Memory routine of FIGURE 10. If the outcome of the test at step 234 is negative, a test is made at step 236 to determine whether the user desires to store a Directory name or a number associated
20 with a Directory name. If so, control is transferred to the Directory Storage routine of FIGURE 11. If the outcome of the test at step 236 is negative, then the system will expect to receive a key word for association with the number to be stored at step 238. A test is thus made at step 240 to
25 determine whether the subscriber has spoken a valid key word. If not, the system responds with an error message at step 242

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and control is returned to step 234. If the outcome of the test at step 240 is positive, the Speech Recognition System makes an inquiry "Storing (key word), correct" and engages the speaker-independent recognition subsystem at step 244. A test is then made at step 246 to determine if the user selection is correct. If not, the Speech Recognition System issues a "Location, please" prompt at step 248 and returns to step 240. A positive outcome of the test at step 246 causes the system to issue a "Storing" prompt while a number associated with the keyword is stored in the data storage subsystem in step 249. Control is then returned to step 112 in FIGURE 5.

The Memory routine is shown in FIGURE 10. The routine begins at step 250 by inquiring "Which memory" and engages the speaker-independent recognition subsystem. At step 252, a test is made to determine if a two digit memory location number has been collected from the user. A timeout test is then performed at step 254. If timeout occurs, the Speech Recognition System prompts the user to "Please enter next digit" at step 256 and control is returned to step 252. A negative outcome of the timeout test also returns control back to step 252.

A positive outcome of the test at step 252 indicates that the two digit memory code has been collected from the subscriber. At step 258, the Speech Recognition System responds with a message "Storing memory (2 digits), correct" and engages the speaker-independent recognition subsystem. A

test is then made at step 260 to confirm that the subscriber is storing the telephone number in the appropriate location.

If not, the Speech Recognition System issues a "Location, please" prompt at step 262 and returns to step 252. A

5 positive outcome of the test at step 260 then causes the routine to test at step 264 whether the memory is already filled up with stored codes. If not, the system issues a "Storing" message and stores the number in the data storage subsystem at step 265. If, however, the response to the test
10 at step 264 is affirmative, the Speech Recognition System issues a "Memory full, erase?" message and engages the speaker-independent recognition subsystem at step 266. A test is then performed at step 268 to determine whether the speaker wishes to erase a memory location. If not, control returns to
15 step 112 in FIGURE 5.

If the subscriber desires to erase a given memory location code, the system issues a "Confirm erase" message at step 270 and engages the speaker-independent recognizer. An erase test is then performed again at step 272 to confirm that
20 the subscriber wishes to erase the specified memory location. A negative outcome of the test at step 272 returns control to step 112 in FIGURE 5. A positive outcome of the erase test at step 272 causes the system to issue an acknowledgment at step 274. Control then returns to step 112 in FIGURE 5.

25 Referring now to FIGURE 11, a flowchart is shown of the Directory Storage routine. The routine begins at step 276 in

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response to a positive response to the Directory inquiry performed in step 236 in FIGURE 9 (i.e., receipt of the Directory command). Step 276 issues a prompt to the subscriber to determine if a "Number in Memory" has been previously associated with a Directory name. A test is then performed at step 278 to determine if the Number in memory has been previously stored. If not, the Speech Recognition System responds by issuing an "Enroll" message and engages the speaker-independent recognition subsystem at step 280. A test is then made at step 282 to determine whether the subscriber wishes to enroll. If not, the routine terminates and returns to step 112 in FIGURE 5.

If the outcome of the test at step 278 is affirmative, the Speech Recognition System issues a message "Re-enroll" and engages the speaker-independent recognition subsystem at step 284. A test is then made at step 286 to determine whether the subscriber wishes to re-enroll the directory name. If yes, or if the outcome of the test at step 282 is positive, the routine continues at step 288 and issues a "Name Please" message and engages the speaker-dependent recognition subsystem. The user then speaks the name a predetermined number (e.g., three (3) times) at step 290 to program the speaker-dependent subsystem. The new directory name and the associated telephone number are then stored in the data storage subsystem in step 292. Control is then returned to step 112 in FIGURE 5.

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If the outcome of the test at step 286 is negative, the Speech Recognition System issues a message "Erase" and engages the speaker-independent recognition subsystem at step 296. A test is then made at step 298 to determine whether the subscriber wishes to erase the directory number. If so, the associated number is erased at step 300. Control is then returned to step 112 in FIGURE 5.

It should be appreciated that the specific names of the commands are merely exemplary and should not be taken by way of limitation. Other suitable command names are of course suitable.

As noted above, each cellular telephone is uniquely identified with its MIN and ESN. In the prior art, the service provider operates the MTX 12 and keeps a database of all MIN's (and their associated ESN's). Each time a call is placed by the cellular telephone, the service provider verifies whether the MIN and the associated ESN are authorized. If the MIN and ESN of a cellular phone are not recognized in the switch database, the provider normally allows the call to proceed at least one time. If billing authorization cannot later be verified, however, the MIN and serial number are then placed on an exception list. Subsequent attempts to use the MIN will then be rejected.

Such fraudulent use of the cellular network is ameliorated by the present invention. According to another feature of the invention, the Speech Recognition System also

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includes a positive identification function that enables the system under certain circumstances to test whether the user associated with a received MIN (whether in or out of the service area) is an authorized subscriber to the service. For
5 example, after a call is voice-dialed and the Send command is spoken, the system might prompt the caller to answer one or more personal questions. Thus, the caller might be requested to speak the social security and/or account number of the subscriber (purportedly associated with the MIN and ESN).
10 Alternatively, the caller can be prompted to enter such identifying information manually through the telephone keypad. Of course, the nature and scope of the personal information requested by the system depends entirely on the system operator and the degree of security sought by the
15 subscriber and operator.

Such a system could also be used to prevent a local call being placed from a stolen vehicle, for example, i.e., even if the MIN was recognized in the service provider's database. It could also be used to limit access to the voice-dialing
20 function from the subscriber's phone to certain persons. Thus the subscriber may limit his or her children or others from using the phone without the subscriber's knowledge. If the user cannot provide proper answers to such questions, the system rejects the SEND command and the call is terminated.
25 Correct entry of the requested information enables the caller to continue his or her access to the service.

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Alternatively the identification function may be implemented in conjunction with a speaker verification function in which the user's identity must first be verified with some spoken predetermined personal identification code.

5 If the verification function is not "convinced" that the person is who he or she claims to be, the identification function is then executed to ask the follow-up questions. One such system is described in copending application Serial No. 07/523,486, filed May 15, 1990, to Hunt et al, titled
10 "Simultaneous Speaker-Independent Voice Recognition And Verification Over A Telephone Network," assigned to the assignee of the present invention.

The present invention has numerous advantages over the prior art. The system combines the use of both
15 speaker-dependent and speaker-independent speech recognition in an mobile or portable telephone communications network environment. Multiple language prompts are spoken from and available simultaneously on multiple ports from a single automated telecommunications-based system. The language
20 selected is based on the language spoken by the user. The system advantageously stores user specific speaker-dependent and speaker-independent speech information with particular user-based addresses.

The invention successfully implements speech recognition
25 in the cellular telephone or personal communications network. Non-wireline networks provide a special challenge to both the

recognition algorithm developers as well as the applications developers. The recognition algorithm in conjunction with the system application is insensitive to the radio fading, speech clipping, and speech compression conditions that occur in a non-wireline network. In addition, the recognition algorithm accommodates conditions found in the standard switched network. The invention provides a means of accurately recognizing speech that has limited distortion due to clipping or fading and provides a means of reprompting the user for input when the speech has become too distorted for accurate recognition.

Previously, only the best examples of spoken words have been used as tokens for developing speech vocabularies. By collecting speech that has been compressed or that although distorted by radio fading or clipping is still intelligible and by adding this collected speech to the speech training database, the vocabulary based on such data becomes more robust and less sensitive to these conditions. Adding the distorted but intelligible data to the training database of excellent example words allows for a more diverse statistical representation of each vocabulary word. Words that might have been previously rejected, because part of the word was clipped can now be recognized if enough intelligible information is available. If the statistical representation of the word indicates that not enough information is available for

accurate recognition, the recognition system will reject the word and reprompt the user for input.

The invention also enables real-time vocabulary uploading. Previously, speech recognition vocabularies were stored in memory and were not updated or totally changed during the operation of an application. The present invention solves the problem of allowing speech recognition vocabularies to be loaded into a recognition system while an application is in operation. This capability allows for less high speed memory to be used in a system, because an entire set of vocabularies is not required to be resident in memory at one time. This capability also allows for efficient memory management when multiple languages are used, because only the language required by the system user need be resident in memory at any one time. Previously, all possible languages required by users would have been stored in memory simultaneously.

Both continuous and discrete recognition techniques are used in the Speech Recognition System of the present invention.

It should be appreciated by those skilled in the art that the specific embodiments disclosed above may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.